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National Fire-Danger Rating System
Progress Report SEVEN

PRESENT STATUS

February of this year saw the publication of the National Fire-Danger Rating (NFDR) System basic document. This contains its description and operating instructions, and is entitled, "National Fire-Danger Rating System." It is the USDA Forest Service Research Paper RM-84. The abstract is repeated here to provide a brief summary of the system.

> "The NFDR System produces three indexes--Occurrence, Burning, and Fire Load--that measure relative fire potentials. These indexes are derived from the fire behavior components--Spread, Energy Release, and Ignition--plus a consideration of Risk.
>
> "Three innovations in fire-danger rating are introduced in the NFDR System. First, it is solidly based on the physics of fire behavior--it is not empirical or statistical. Second, it makes use of the fuel model, an open-ended means of treating the myriad of naturally occurring fuel situations. Third, the system is designed so that improvements can be incorporated with a minimum of impact on the users.
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> "Fuel moisture, wind, and risk are the principal variables accounting for the day-to-day fluctuations of fire danger. In the NFDR System, three classes of dead fuels and two of live fuels are recognized. Rainfall duration is the predictor of the effect of rainfall on the moisture content of dead fuels. Very important, also, is the time fuels are exposed to solar radiation (sunshine).
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> "Nine fuel models are introduced; each represents a broad grouping of fuel types with common characteristics. These characteristics, when evaluated, are the numerical

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fuel inputs required to solve the mathematical equations which yield the Spread and Energy Release components. The number of fuel models can be increased to provide the resolution necessary to meet the future needs of fire management organizations.

"Risk is evaluated for lightning and man-caused fires. Both evaluations are subjective, but the schemes presented are considered adequate until more objective approaches can be developed.

"Instructions and tables necessary to manually compute the indexes and components for all nine fuel models are presented. The format is designed so that agencies can incorporate these instructions into directives as a technical supplement."

Nearly 7,000 copies of this handbook have already been distributed. For a detailed description of the system, please refer to the document. Most of its 165 pages consist of sets of tables for each of the nine fuel models. Identical tables are repeated as needed in each model, so that complete sets may be removed if desired, for field use. No revisions are planned before 1975. Changes then will be in numerical values only, and users will need to make only minor adjustments to accommodate them.

Implementation work has rapidly moved ahead. The U.S. Forest Service has adopted the system, and it is already in use in U.S. Forest Service Regions 2, 3, 4, and 6. By early 1973, it will be the official U.S. Forest Service system in all regions. Most other federal agencies plan to make the changeover during 1973. We know of at least 13 states that have been experimenting with the system on a trial basis this year. Most indicate that they are planning adoption for the 1973 season.

1. Personnel

A fourth scientist is now on the project with the transfer of James R. Davis from Flagstaff, Arizona. Jim has been working on prescribed fire problems in the Southwestern chaparral type. Prior to his assignment there, he worked at the Southern Forest Experiment Station, at Nacogdoches, Texas. He has had extensive experience in weather instrumentation and measurement, fuel measurement, and burning techniques. His addition to the project staff will strengthen our capability in several important areas.

2. Implementation Aids

Because of the need for data analyses work prior to adoption, our computer program FIRDAT was prepared, and training in its use was given

in November 1971. This program, with continuing modification and analysis of its output, will continue as the chief aid for users. Computer applications allow for quick, economical examination of historical fire danger records. The principal requirement is that these data be available for electronic processing.

An additional aid, primarily in the area of training observers, a programmed text has been prepared. This was done in cooperation with the USFS National Fire Training Center, at Marana, Arizona.

Fire climate analysis is a necessary corollary for the best application of the system. Computer applications have made this possible over broad areas in several regions. The procedure followed involves scalar analysis, and is best applied by an experienced fire-weather forecaster.

A real-time, interactive computer program has been devised as the first step in possible wide-scale automation of the NFDR System. It is currently being tested and will be available for intensive trials next year. When completed, it will be available for use by any agency, state, or private firm from any location within the United States. It utilizes a time-share computing system, which makes these facilities available at most telephone installations.

Although the design is not yet complete, the interactive program is planned to accomplish the following:

a. Compute all components and indexes from observed data.

b. Compute forecasted components and indexes from fire weather and risk forecasts.

c. Present both observed and forecast manning or readiness levels (class of day).

d. Store and recall data, including archiving.

e. Achieve universal availability to all users.

Bill Furman has worked with Bob Helfman, of the Riverside Fire Laboratory to bring this system along. It should be completed, tested and available for general use in about 15 to 18 months.

3. Extension Work

Since the last progress report, much of our time has been involved in the development and testing of the implementation aids. Application of such aids and training in the use of the system has required additional time. We plan to continue responding to requests for this type of assistance as time will allow.

We have arranged for scientists at several USFS research installations to operate as part-time field representatives for the NFDR System. These include:

James T. Paul	Southern Forest Fire Laboratory	Macon, Ga.
Von J. Johnson	North Central Forest Exp. Stn.	East Lansing, Mich.
William C. Fischer	Northern Forest Fire Laboratory	Missoula, Mont.
Mark J. Schroeder	Forest Fire Laboratory	Riverside, Calif.
Richard Barney	Forestry Sciences Laboratory	Fairbanks, Alaska

Requests for assistance, or questions, comments and suggestions can be directed to these folks.

FIRE-WEATHER AND FIRE-DANGER RATING SEMINARS

A continuation of the Fire Research Seminars this coming fall and winter will present programs on Fire Danger and Fire Weather. Interagency cooperation has made these efforts possible, with credit due primarily to Mark Schroeder's Fire Meteorology unit at Riverside, Calif.; and to the National Weather Service, USDC and the Bureau of Land Management, USDI.

The schedule is:

10/17-19/72	North Central Forest Exp. Stn.	East Lansing, Mich.
11/14-16/72	Northern Forest Fire Laboratory	Missoula, Mont.
12/12-14/72	Southern Forest Fire Laboratory	Macon, Ga.
1/16-18/73	Forest Fire Laboratory	Riverside, Calif.

The objectives of these seminars are to review and extend fire weather principles, to identify the role of weather in fire-danger rating, to review the structure and application of the new National Fire-Danger Rating System, and to provide examples of the application of fire weather and fire danger principles to regional fire problems. Additional subjects from fire weather forecasting, case histories of critical fire danger periods, and fire weather research will be covered.

The seminars are intended for middle-management fire personnel in federal, state, and private forestry organizations. The material is designed for the "user" and "doer" personnel, who need to keep abreast of current knowledge, and who also need to train others in their organizations.

A special seminar presentation was made in September at Anchorage, Alaska. Again, cooperation played a major part, with special assistance coming from the Alaska State Office, Bureau of Land Management, and the National Weather Service at Anchorage.

CONTINUING STUDIES

1. Fuel Moisture Analog

For computations of observed fire danger, direct measurement of fuel moistures can result in the elimination of use of six tables in fuel models that require all three fuel moisture inputs. This is best done by use of a fuel analog--a device that duplicates moisture responses in natural fuels. Such an analog has been developed and is currently undergoing field tests. Dr. J. D. Plunkett, of Denver is the contractor. The work has been handled for the project by Mike Fosberg and Wally Lancaster.

At the present time, measurement must be done by weighing, as with sticks. A better method would be electronic sensing of moisture contents. Electronic measurements would also facilitate telemetry of observational data. Technology surveys are now underway that should reveal whether this problem is solvable with current state-of-the-art methods.

One major consideration must always be that of cost. Present projections are that a manual weighing installation, using scales such as those presently in use, is one economical solution. This scheme, however will probably still require use of tables to arrive at moisture content. However, answers will be more accurate than those arrived at now by bookkeeping methods. But if electronic measurement can be achieved, calibration can also be electronic and use of tables minimized. Our goal is to keep analog electronics costs within reach of most users. We are not sure just what an acceptable cost is, but we should have a reasonable estimate for electronics within the next year.

In the meantime, continued development and testing of the analogs by weighing methods is scheduled for this year. Extensive data is needed on moisture responses, weathering effects, radiation influences, handling characteristics, atmospheric pollutant effects, calibration, and measurement techniques. These tests will help make certain that operational failures are minimized, and will explore measurement alternatives that seem workable. Full development of a special weighing system for data collection must necessarily precede the electronic moisture sensing devices. It will probably require 10 to 12 months to complete work on the weighing phase, with perhaps an additional year needed for the electronics phase.

2. Risk Investigations

We recognize that an important need in the system is an objective assessment of risk. A usable subjective approach has been provided in RM-84. Nevertheless, in order to arrive at the most reliable fire

load index evaluation, subjective estimates must be minimized. Man-caused risk is the chief problem area that will be dealt with first. Studies of this factor will be initiated as soon as practicable.

3. Telemetry Systems

Our charter presently includes the responsibility of investigating fire weather telemetry systems. This is a cooperative project, shared with the Equipment Development Group at Missoula, Montana. The first effort is in the area of systems analysis, and a small contract was let in June for a preliminary study. This includes an examination of the problem, plus a look at operational observing systems and consideration for possibilities of technology transfer.

4. Other Studies

Mike Fosberg is continuing work on the moisture responses of duff and litter. Field collection and measurements have been made. Laboratory and analytical work is underway with computer simulation a mainstay. More accurate estimates of duff and litter moisture values will strengthen the system.

Fire climate work is progressing well, and an interim method for analysis has been devised and used. The goals here are to devise a methodology that will permit the delineation of fire-danger rating areas, and the definition of an optimum fire danger station network.

Moisture responses of fuels that are snow covered part of the year remain somewhat of a mystery. We now have a special study underway that will examine moisture trends of fuels under snowpack conditions. It will follow these trends through the snow cover cycle, and should reveal much regarding assumptions that have been made for many years. It should indicate the extent that additional snow studies may be needed, and point the way for analog use in duff and litter fuels.

A small contract has recently been completed for the development of a precipitation duration recorder. Here again, cost is a major consideration. We believe that duration of such events must be satisfactorily recorded for a very modest investment. We are currently testing six prototypes. If they perform satisfactorily, specifications will be written and a pricing structure solicited.

5. Areas of Special Interest

We will continue to work with applications of fire-danger rating to resource management problems. This involves the use of ratings of

fire danger as objective aids to resource decisions. As an example, rating gives a means of evaluating different vegetative cover types with respect to their inherent fire hazards.

An informal writeup of our recommendations concerning implementation of the system has been assembled. We will add to these from time to time as problems are identified. These recommendations are available on request.

A valuable tool for the fire manager would be represented in a quick means of arriving at improved estimates of fire behavior on a specific going fire. Dispatchers have used altitude and aspect tables and conversion meters. This problem will get some attention in the next couple of years.

Our activities involving danger rating in prescribed fire, critical fire weather studies, project fire decisions, and environmental concerns must necessarily be limited, for the present. Our interest, however, in these areas continues high, and we hope to give them increased attention in our work program in the future.

The project phone number is 303-482-7332. FTS users can dial 303-484-2211. Our address is:

Rocky Mountain Forest and Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80521

Comments and suggestions will be welcome.